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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/388,826	09/01/1999	WEIMIN LI	MI22-1208	4483

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EXAMINER
KIELIN, ERIK J

ART UNIT	PAPER NUMBER
2813	27

DATE MAILED: 06/04/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/388,826	LI ET AL.	
	Examiner	Art Unit	
	Erik Kielin	2813	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *13 May 2002* .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *102-134* is/are pending in the application.

4a) Of the above claim(s) *125 and 132* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *102-124,126-131,133 and 134* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 19, 22, 24, 26.
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other:

DETAILED ACTION

Election/Restrictions

1. Applicant's election of claims 102-124, 126-131, 133, and 134 in Paper No. 25 is acknowledged. Because applicant did not distinctly and specifically point out the supposed errors in the restriction requirement, the election has been treated as an election without traverse (MPEP § 818.03(a)).

2. Claims 125 and 132 are withdrawn from further consideration pursuant to 37 CFR 1.142(b) as being drawn to a nonelected species, there being no allowable generic or linking claim.

Specification

3. The amendment filed 3/5/02 is objected to under 35 U.S.C. 132 because it introduces new matter into the disclosure. 35 U.S.C. 132 states that no amendment shall introduce new matter into the disclosure of the invention. The added material which is not supported by the original disclosure is as follows: Applicant does not appear to have support for the added phrase "between the plates of" to describe the spacing.

Applicant is required to cancel the new matter in the reply to this Office Action.

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person

having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

5. Claims **102**-110, 112-124, 126-128 and **129**-131, 133, 134 are rejected under 35 U.S.C. 103(a) as unpatentable over **Yau** et al. (US 6,072,227) in view of Morita (JP 63-157443 A).

Yau discloses the substrate **512** (Fig. 8A) having at least partially formed integrated circuitry formed thereon; depositing thereon a low k dielectric layer **510, 518**, (which may be a liner layer, cap layer, intermetal dielectric layer, or etch stop layer; [Abstract]) using a PECVD method with precursors of, for example, methylsilane and an oxygen containing gas, such as O_2 or N_2O (col. 5, lines 35-37). Note that the dielectric layer is porous (col. 3, lines 13-29) and has a dielectric constant of less than 3.0 (**Yau**, claim 13) and in one example, a dielectric constant of 2.5 (col. 15, lines 5-18). The layer has from 1% to 50 % carbon from $Si\text{-}CH_3$ bonds. (See also, col. 12, line 41 to col. 13, line 52.)

Yau does not teach plasma treating the dielectric layer with oxygen plasma.

Morita discloses a very similar method to **Yau** comprising forming a low-dielectric-constant material comprising phenyl or alkyl silicon oxide **10** which inherently has a dielectric constant of less than 3.5 over an integrated circuit Fig. 2; blanket exposing the dielectric to oxygen plasma to form and upper surface 11 of silicon oxide which is inherently effective to reduce the dielectric constant. (See Figs. 1-2; page 2, lower two column.) Note that a whole of the dielectric layer is not converted from one base to another (Applicant's claim 19) and that the $(CH_3)_xSiO_y$ remains as $(CH_3)_xSiO_y$. Note that the plasma exposure time is 10 minutes. Regarding claim 14, **Morita** forms the organic silicon oxide layer using $R_nSi(OH)_{4-n}$ wherein R is any alkyl

group. Examiner repeats the unchallenged official notice that alkyl includes methyl as this is the simplest of the alkyl group members. (See Hackh's, *supra*.)

To quote from **Morita** at page 5,

> "When this semiconductor substrate 1 is exposed to an **oxygen plasma** for ten minutes, the **organic functional groups** of **organic** silicon thin film 10 **are removed** to a desired depth, transforming into a silicon oxide film. As such, the film thickness of organic silicon thin film 10 as initially formed, in its thinnest portions, transforms **nearly** entirely to silicon oxide film 11; only in the thickest portion does it come so as to have **a two-layer structure of silicon oxide film 11 and organic film 10** (figure 3)." (Emphasis added; page 5 of translation, lines 5-14).

Morita teaches that the oxygen plasma treatment solves the problem of poor insulation of the upper portion of organic spin-on glasses by removing the excess organic moieties at the surface, while beneficially preserving adhesion to the underlying layers by leaving the organic moieties in the lower portion of the film. (See translation provided by Applicant, section entitled "FUNCTION" beginning on p. 3.)

Accordingly, it would have been obvious for one of ordinary skill in the art, at the time of the invention to modify **Yau** to carry out the plasma treatment in **Morita** for the reasons just indicated in **Morita** for carrying out the plasma treatment. As indicated the dielectric would inherently be lowered because Applicant indicates that an oxygen plasma treatment will lower the dielectric constant. This makes common sense since the organic portion removed will leave behind additional porosity in the **Yau** dielectric layer, and space has the lowest dielectric constant attainable thereby lowering the overall dielectric constant of the layer.

Regarding claim 103, **Yau** discloses O_2 and N_2O and any oxygen containing gas, as noted above.

Regarding claims 104, 105 as noted above, **Morita** teaches oxygen which is not water and is therefore, dry oxygen.

Regarding claim 106-108, **Yau** discloses nitrous oxide, N_2O.

Regarding claim 109, **Yau** discloses methyl silane and N_2O deposition, and **Yau** teaches oxygen plasma exposure.

Regarding claim 110, the stability of the dielectric layer is inherently increased for the reasons indicated in **Morita** and by Applicant.

Regarding claim 112, **Morita** teaches that the organic silicon film is cured at 450 °C and no heating appears to be indicated; therefore, the temperature during exposure must be less than 550 °C.

Regarding claim 113, the **Morita** exposure is not indicated to etch.

Regarding claims 114-115, 122, 123, and 130, both **Yau** and **Morita** make the film from at least methylsilane. **Yau** specifically indicates that the film has from 1-50% carbon arising from Si-C bonds, preferably 20%. (col. 5, lines 12-44). Furthermore, Applicant has not indicated any criticality to the claimed portions. See In re Hoeschele, 406 F.2d 1403, 160 USPQ 809 (CCPA 1969) (Claimed elastomeric polyurethanes which fell within the broad scope of the references were held to be unpatentable thereover because, among other reasons, there was *no evidence of the criticality* of the claimed ranges of molecular weight or molar proportions.). Any difference is a matter of routine optimization within prior art general conditions. (See MPEP 2144.05.)

Regarding claim 116, **Morita**, as noted above indicates that the exposure the organo dielectric leaves the organo dielectric substantially as its original composition. Since **Yau**

teaches Applicant's specific method of deposition using Applicant's claimed methylsilane, the deposited film is $(CH_3)_XSiO_Y$, which would stay "substantially as $(CH_3)_XSiO_Y$" according to the teachings in **Yau** and by Applicant.

Regarding claims 117-121, although the time is not exactly as claimed by Applicant, it has been held that claimed ranges of a result effective variable, which do not overlap the prior art ranges, are unpatentable unless they produce a new and unexpected result which is different in kind and not merely in degree from the results of the prior art. See In re Huang, 40 USPQ2d 1685, 1688(Fed. Cir. 1996). In the instant case, there exists no evidence of record to indicate that some unexpected result arises from the claimed time range relative to that in the applied art. It would have been obvious for one of ordinary skill in the art, at the time of the invention to use a shorter exposure time than in **Morita** since the dielectric layer formed by **Yau** is already porous and oxidized by the method of deposition rather than being a solid mass formed by a spin-on technique. The choice of exact time is an obvious matter of routine optimization to provide the best dielectric layer with the lowest reasonable dielectric constant.

Regarding claim 124 and 131, as noted above, the insulative layer may be an interlayer dielectric.

Regarding claims 126-128, 133, and 134, the **Yau** deposited dielectric layer is deposited with a dielectric constant of 2.5, as noted above. It is held absent evidence to the contrary that the dielectric constant is reduced by at least 10% or about 15% by exposure to the oxygen plasma and that the dielectric constant is inherently stabilized. If it is thought for some reason that the dielectric constant is not reduced or is not stabilized by exposure to the oxygen plasma, then these may be a difference. But, it has been held, where the Patent Office has reason to believe

that a functional limitation asserted to be critical for establishing novelty in the claimed subject matter may, in fact, be an inherent characteristic of the prior art, it possesses the authority to require the applicant to prove that subject matter shown to be in the prior art does not possess the characteristics relied on. (See MPEP 2112.) Given the similarity (if not equality) of the dielectric materials formed, the present evidence indicates that the dielectric constant must necessarily be reduced and stabilized.

6. Claim 111 is rejected under 35 U.S.C. 103(a) as being unpatentable over **Yau** in view of **Morita**, as applied to claims **102**-110, 112-124, 126-128 above, and in further view of **Miyasaka** (US 6,017,779).

The prior art as explained above discloses all of the limitations of the claimed invention except for (1) depositing the $(CH_3)_xSiO_y$ layer and exposing in the same chamber is not taught (Applicant's claims 8 and 34); and (2) shutting off the silicon process gas and maintaining conditions in the chamber to expose the dielectric to the oxygen plasma is not taught (Applicant's claim 35).

Miyasaka teaches a method of forming a silicon oxide layer on a semiconductor device using plasma-enhanced CVD with silicon-containing compound and a oxygen-containing gas and then shutting off the silicon-containing precursor and then exposing to the oxygen plasma in the same chamber maintained at sub-atmospheric pressure. (See **Miyasaka**, column 44, "Example 6" especially lines 35-52.)

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify either of **Yau** in view of **Morita** to maintain a device in a single chamber as

taught by **Miyasaka** in order to beneficially prevent contamination to the semiconductor device dielectric layer between process steps, as is well known in the art to do, and furthermore, because it would simplify the process dramatically by preventing a switch in chambers.

Response to Arguments

7. Applicant's arguments with respect to claims 102-134 have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Erik Kielin whose telephone number is 703-306-5980. The examiner can normally be reached on 9:00 - 19:30 on Monday through Thursday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri can be reached at 703-306-2417. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9318 for regular communications and 703-872-9319 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

Erik Kielin
May 20, 2002